



Status of MODIS and VIIRS Instruments

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Acknowledgements:

MODIS Characterization Support Team (MCST)

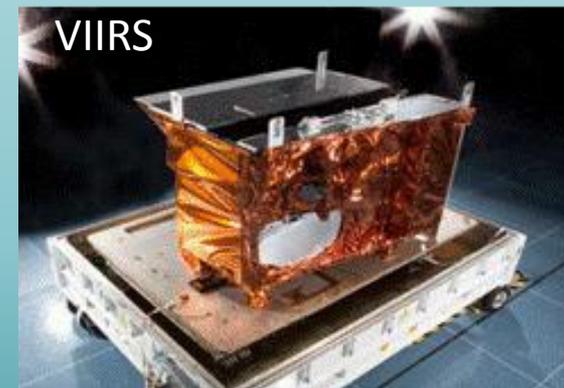
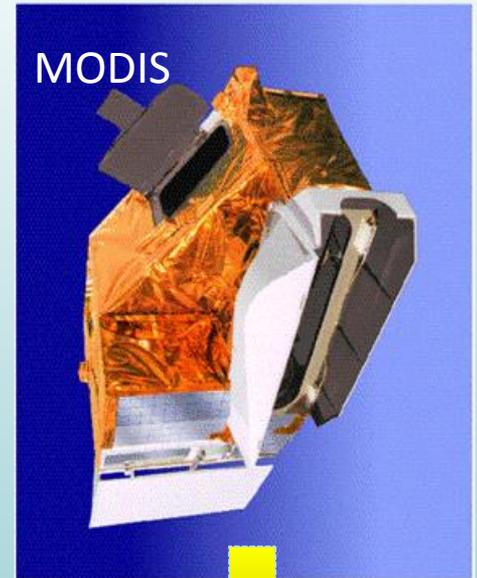
VIIRS Characterization Support Team (VCST)

Outline

- MODIS and VIIRS Instruments
- On-orbit Calibration and Characterization
- Performance (reflective solar bands)
- Status of MODIS and VIIRS L1B Data Products
- Challenging Issues and Future Efforts
- **L8 OLI Calibration Activities and Status**

MODIS and VIIRS Instruments

- **MODIS on both Terra and Aqua**
 - Terra: Dec. 18, 1999 – Present
 - Aqua: May 04, 2002 – Present
- **VIIRS on S-NPP and JPSS**
 - Suomi NPP: Oct. 28, 2011 – Present
 - J1: Launch in late 2016 or early 2017 (ready for S/C environment testing)
 - J2: Launch in 2020
 - J3 and J4: TBD



**Calibration Effort (Pre-launch and On-orbit)
MCST and VCST at NASA GSFC**

Key Design Features

MODIS

- Purpose: Global observations of land, ocean, & atmosphere parameters at high temporal resolution (< 2 days)
- 2-sided scan mirror
- Spectral range: 36 bands between 0.4 μm and 14.5 μm
 - 20 RSB and 16 thermal emissive bands (TEB)
- Focal plane assemblies (FPA): VIS, NIR, SMIR, and LWIR
- Spatial resolution: 250, 500, 1000 m
- Swath Width: 2230 km
- On-board Calibrators: SD, SDSM, BB, SV, and SRCA
- SD aperture door

VIIRS

- Purpose: Global observations of land, ocean, & atmosphere parameters at high temporal resolution (daily)
- Rotating telescope plus HAM
- Spectral range: 22 bands between 0.4 μm and 12.5 μm
 - 14 RSB, 7 TEB, and 1 Day Night Band (DNB)
- Focal plane assemblies (FPA): VIS/NIR, SMIR, and LWIR
- Spatial resolution: 375 and 750 m
- Swath Width: 3000 km
- On-board Calibrators: SD, SDSM, BB, SV,
- Pixel aggregations and bowtie deletion

Nearly 40 science data products from MODIS and 22 EDRs from VIIRS

Spectral Bands

16 Moderate (radiometric) bands, 5 Imaging bands, 1 DNB

VIIRS Band	Spectral Range (um)	Nadir HSR (m)	MODIS Band(s)	Range	HSR
DNB	0.500 - 0.900				
M1	0.402 - 0.422	750	8	0.405 - 0.420	1000
M2	0.436 - 0.454	750	9	0.438 - 0.448	1000
M3	0.478 - 0.498	750	3 10	0.459 - 0.479 0.483 - 0.493	500 1000
M4	0.545 - 0.565	750	4 or 12	0.545 - 0.565 0.546 - 0.556	500 1000
I1	0.600 - 0.680	375	1	0.620 - 0.670	250
M5	0.662 - 0.682	750	13 or 14	0.662 - 0.672 0.673 - 0.683	1000 1000
M6	0.739 - 0.754	750	15	0.743 - 0.753	1000
I2	0.846 - 0.885	375	2	0.841 - 0.876	250
M7	0.846 - 0.885	750	16 or 2	0.862 - 0.877 0.841 - 0.876	1000 250
M8	1.230 - 1.250	750	5	SAME	500
M9	1.371 - 1.386	750	26	1.360 - 1.390	1000
I3	1.580 - 1.640	375	6	1.628 - 1.652	500
M10	1.580 - 1.640	750	6	1.628 - 1.652	500
M11	2.225 - 2.275	750	7	2.105 - 2.155	500
I4	3.550 - 3.930	375	20	3.660 - 3.840	1000
M12	3.660 - 3.840	750	20	SAME	1000
M13	3.973 - 4.128	750	21 or 22	3.929 - 3.989 3.929 - 3.989	1000 1000
M14	8.400 - 8.700	750	29	SAME	1000
M15	10.263 - 11.263	750	31	10.780 - 11.280	1000
I5	10.500 - 12.400	375	31 or 32	10.780 - 11.280 11.770 - 12.270	1000 1000
M16	11.538 - 12.488	750	32	11.770 - 12.270	1000

→ 1 DNB

14 RSB
(0.4-2.3 μm)

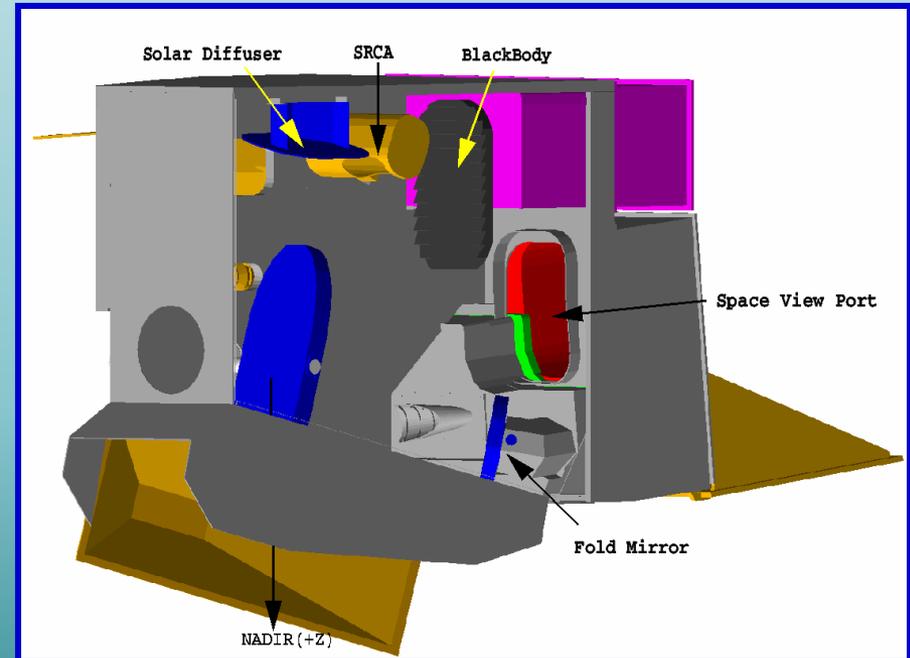
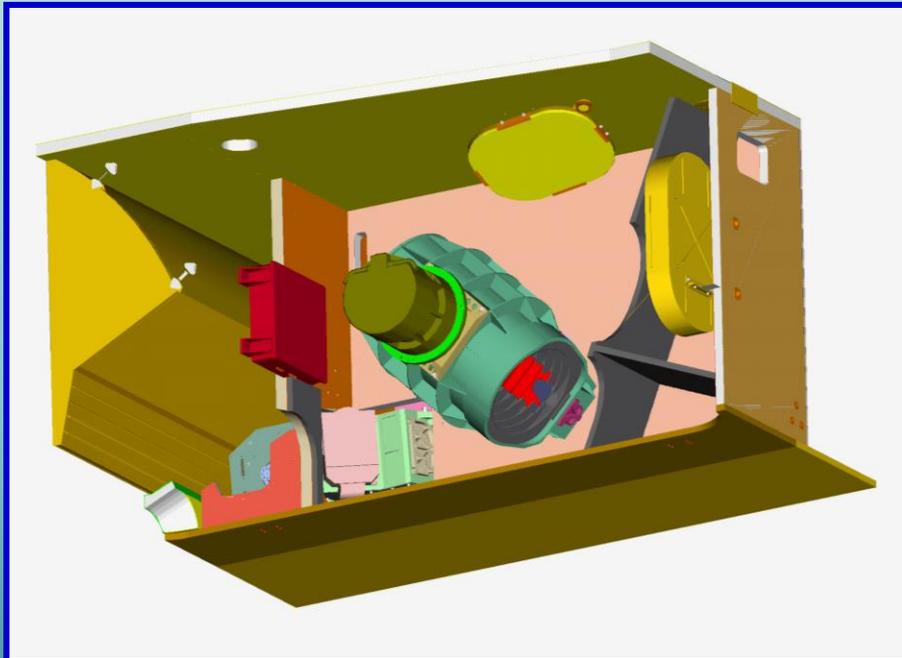
Dual Gain Bands:
M1-M5, M7, M12

7 TEB

On-orbit Calibration and Characterization

On-board Calibrators:

- Solar Diffuser (SD)
- Solar Diffuser Stability Monitor (SDSM)
- Blackbody (BB)
- Space View (SV)
- Spectroradiometric Calibration Assembly (SRCA) - MODIS only



VIIRS On-orbit Calibration and Characterization

- **SD and SDSM Calibration**

- SD calibration performed every orbit (no SD door and no scheduling required)
- SDSM operated mostly on a daily basis until May 16, 2014 and then at a reduced frequency (3 times weekly) and short duration

- **Lunar Calibration (28)**

- Regularly scheduled via S/C roll maneuvers (8-10 times / year)
- Performed at nearly the same phase angles (-51°)

- **BB Calibration and Its Warm-up/Cool-down (12)**

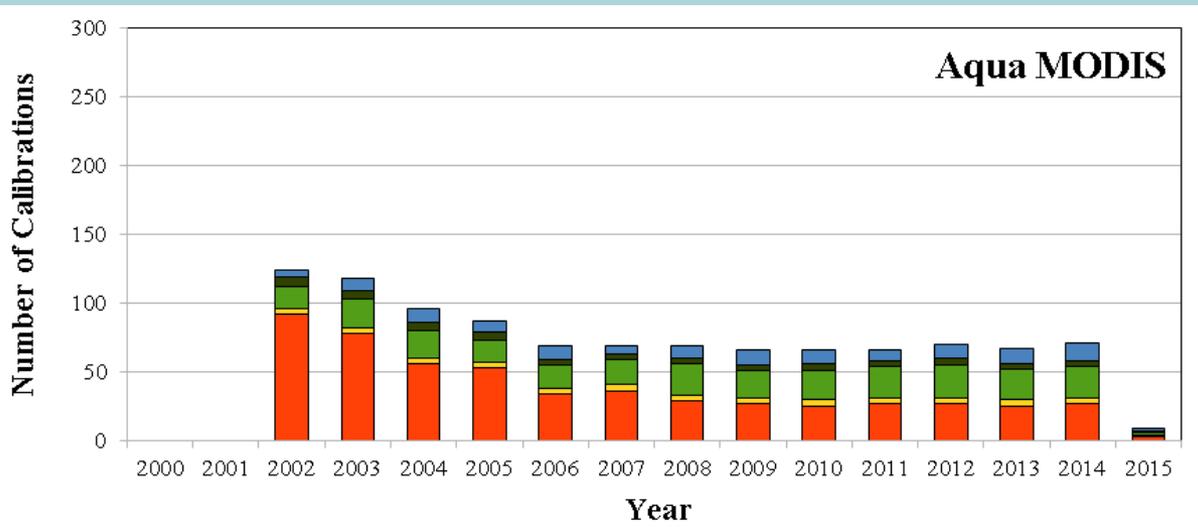
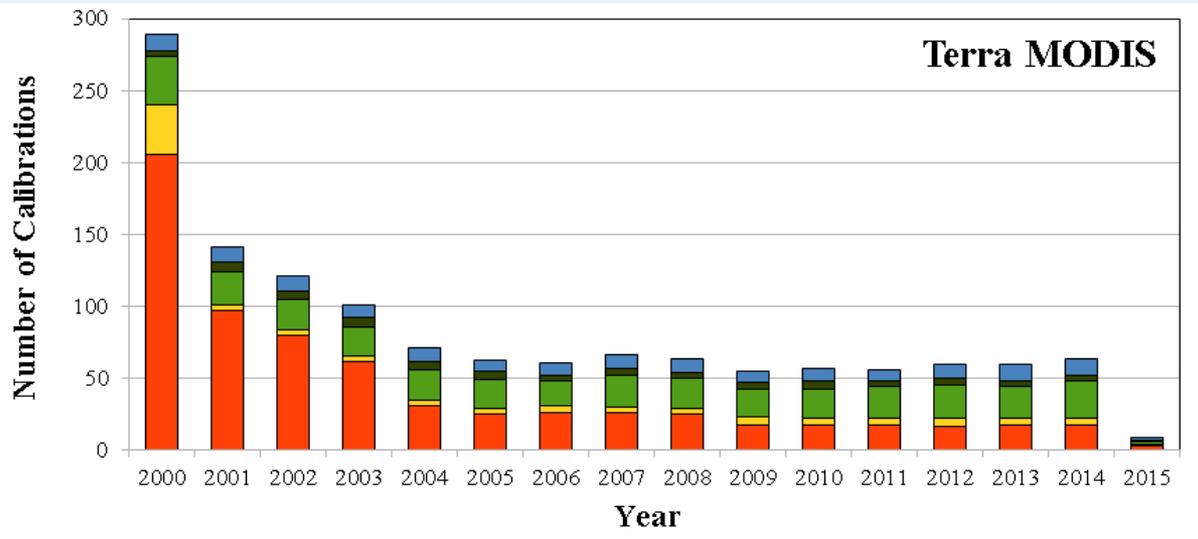
- Nominally controlled at 292.5 K (no schedule is needed)
- Periodic warm-up and cool-down (scheduled on a quarterly basis)
- Most recent on Dec 12, 2014

- **Calibration Maneuvers**

- Pitch, yaw, and roll maneuvers executed during Intensive Cal/Val (ICV) phase at the mission beginning

MODIS On-orbit Calibration and Characterization

Through 2/28/15



Lunar Roll	147	120
PV Ecal	75	63
SRCA	335	264
BB	94	55
SD/SDSM	688	536

	Terra	Aqua
Lunar Roll	147	120
PV Ecal	75	63
SRCA	335	264
BB	94	55
SD/SDSM	688	536

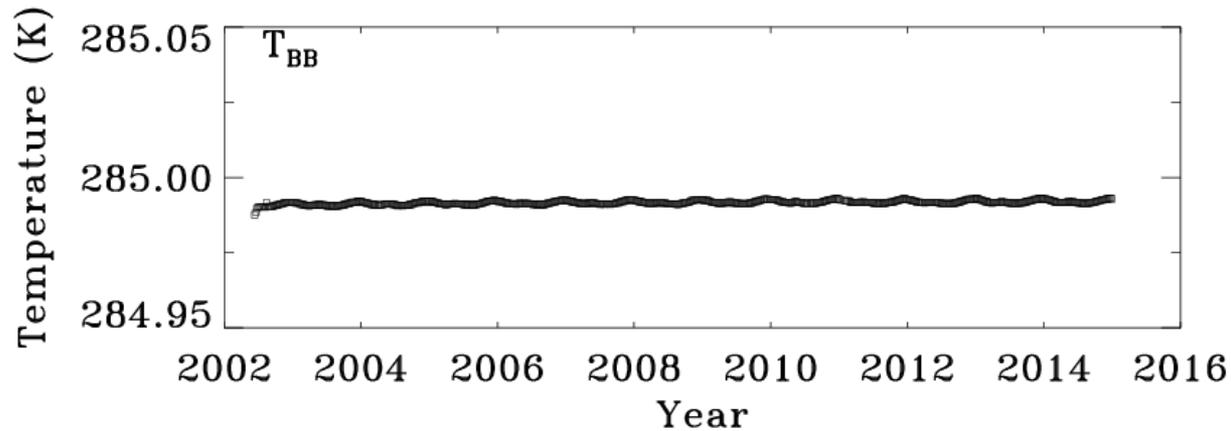
Others:
Maneuvers
Ground targets
Inter-comparisons
Nighttime day mode ops

BB WUCD: 270 - 315K; SRCA: 3 modes

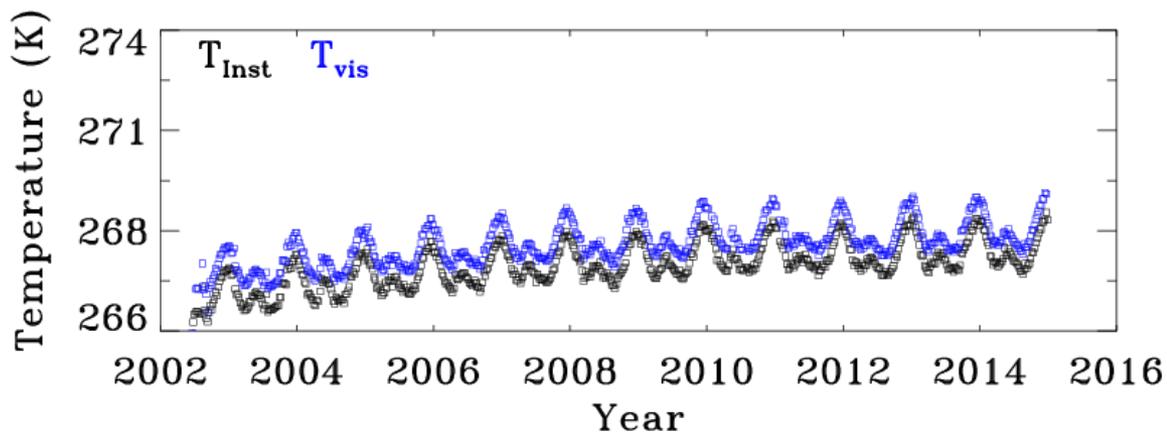
On-orbit Performance

- **Instrument Operation Environment: stable**
- **OBC Functions: normal**
- **BB Calibration: stable with its temperature accurately controlled**
- **SD Degradation: larger degradation at shorter wavelength**
- **Radiometric Response:**
 - Large changes in VIS and NIR for MODIS
 - Large changes in NIR/SWIR for VIIRS (due to mirror contamination)
 - Very small changes for TEB
- **Spectral Responses:**
 - Small changes in CW and BW for MODIS (via SRCA)
 - Modulated RSR for VIIRS (via optics degradation modeling)
- **Spatial Band-to-Band Registration (BBR): stable**

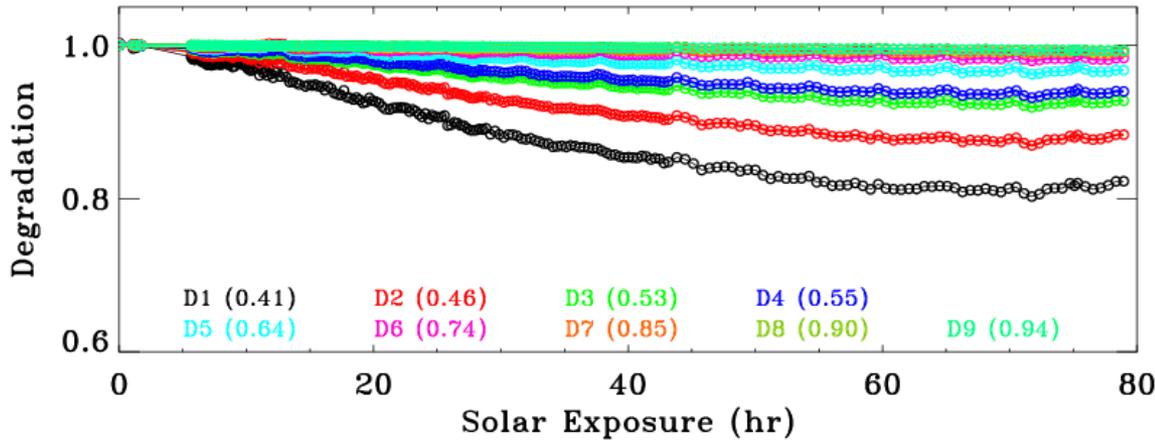
Aqua MODIS BB and VIS/NIR FPA Temperatures



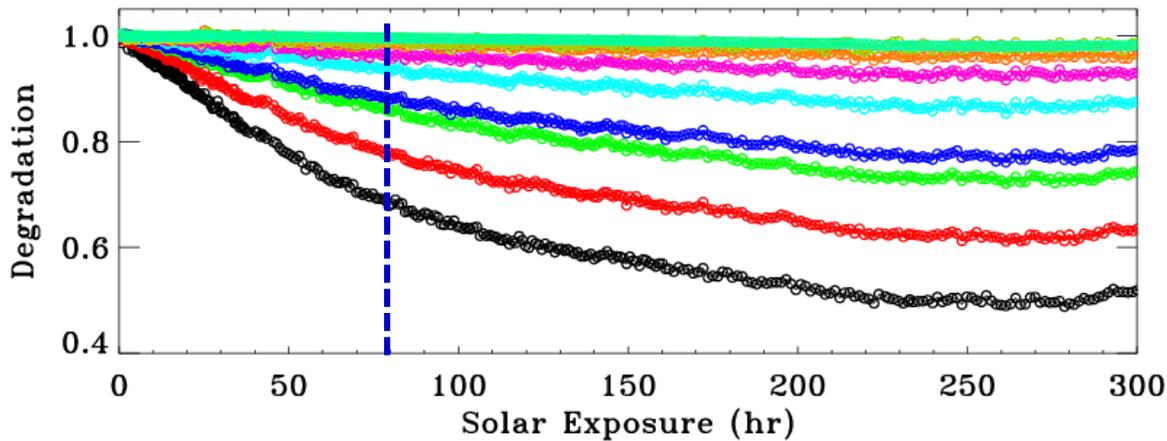
Aqua MODIS and S-NPP VIIRS is more stable than Terra MODIS



Solar Diffuser (SD) Degradation

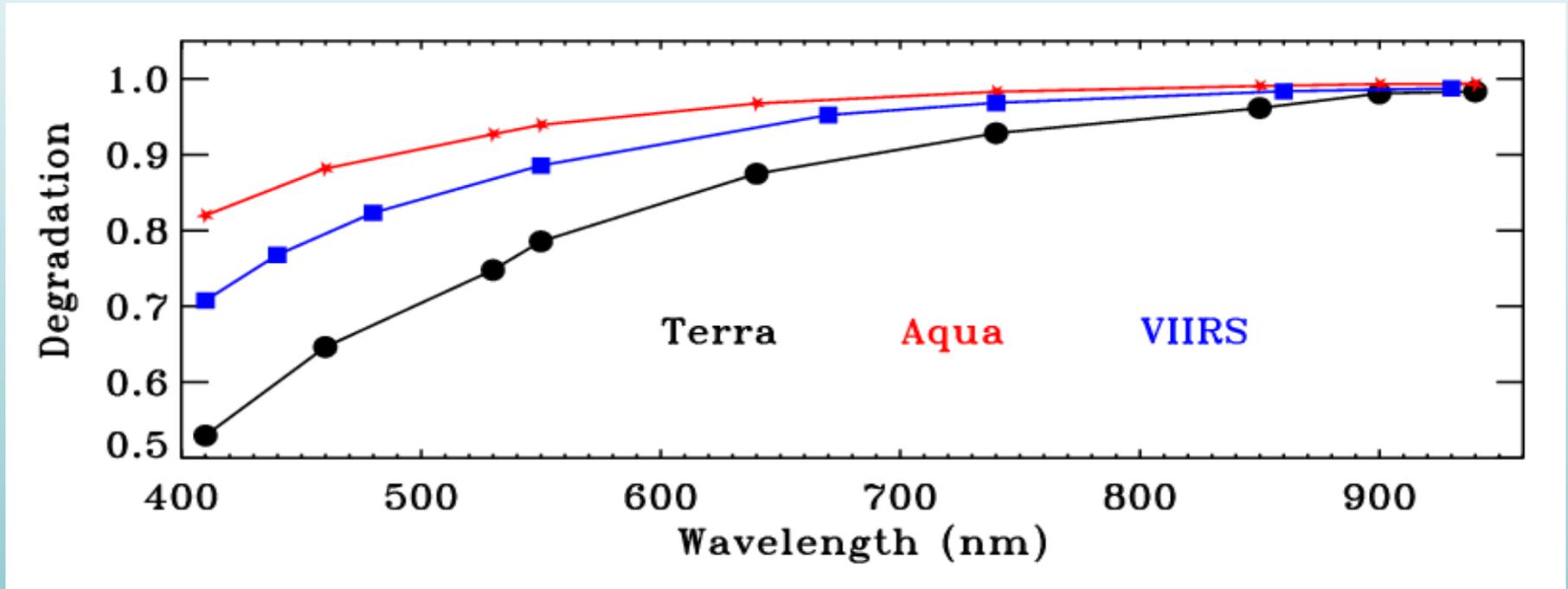


Aqua MODIS



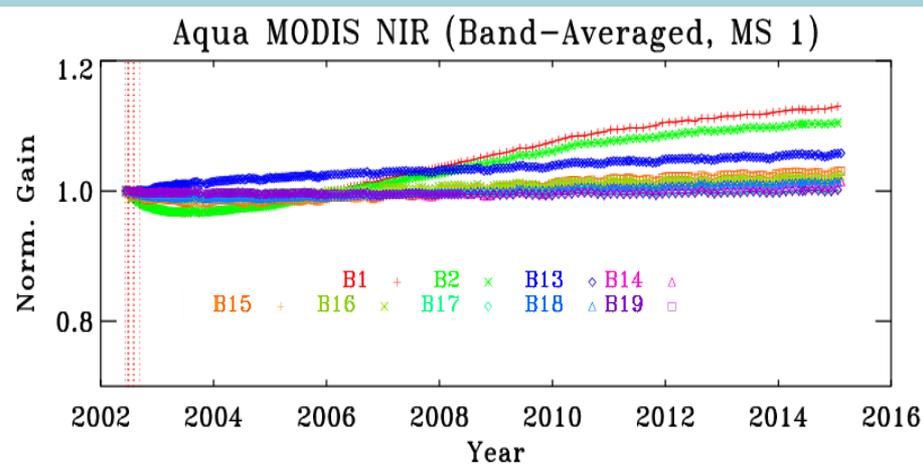
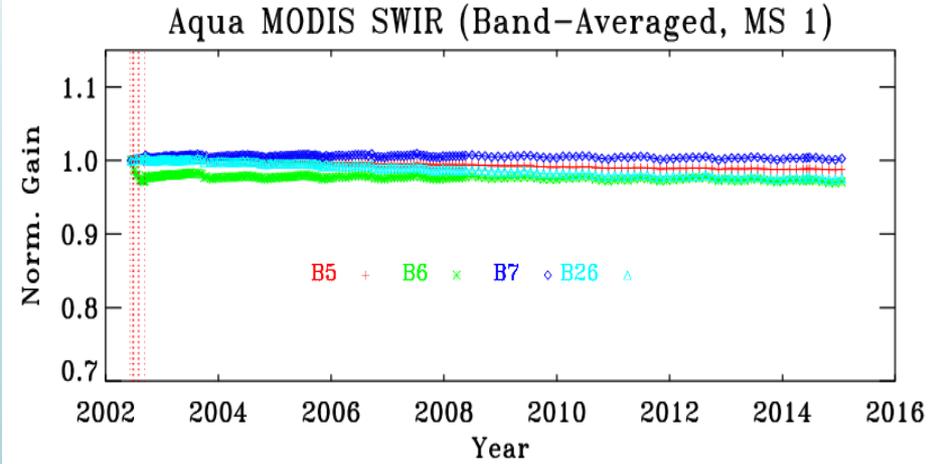
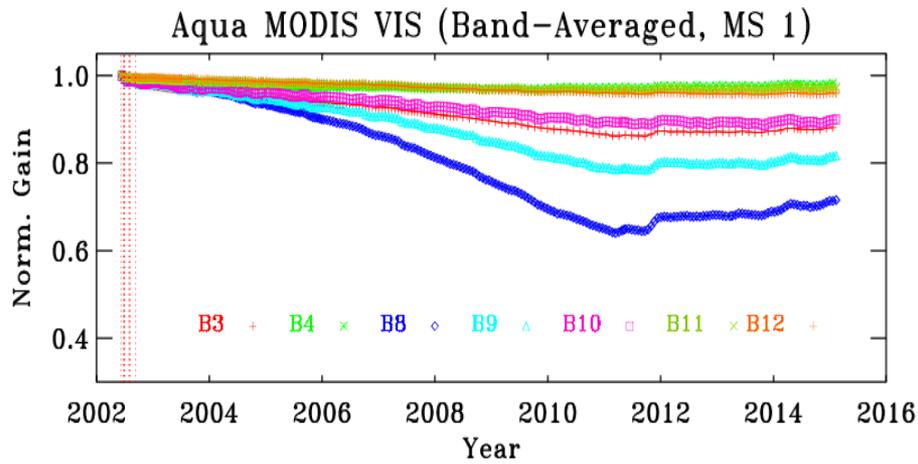
S-NPP VIIRS
No SD Door

Solar Diffuser (SD) Degradation



SD degradation: strong wavelength dependence

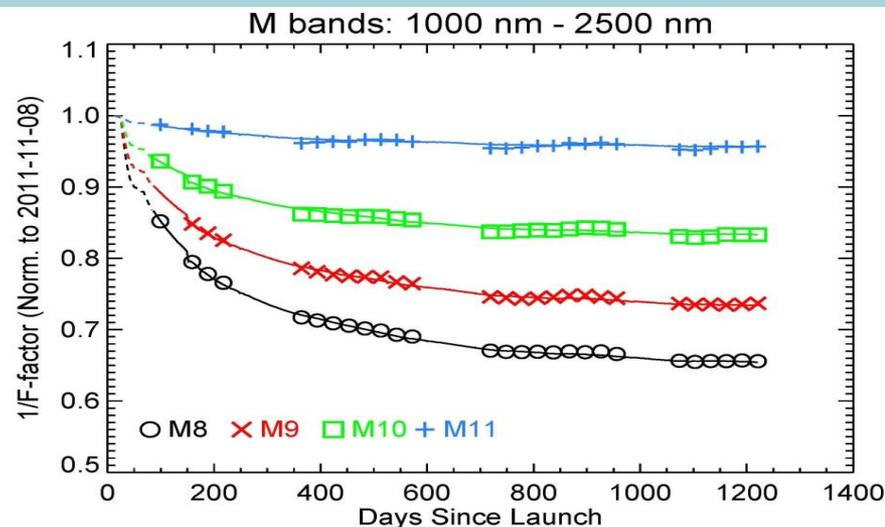
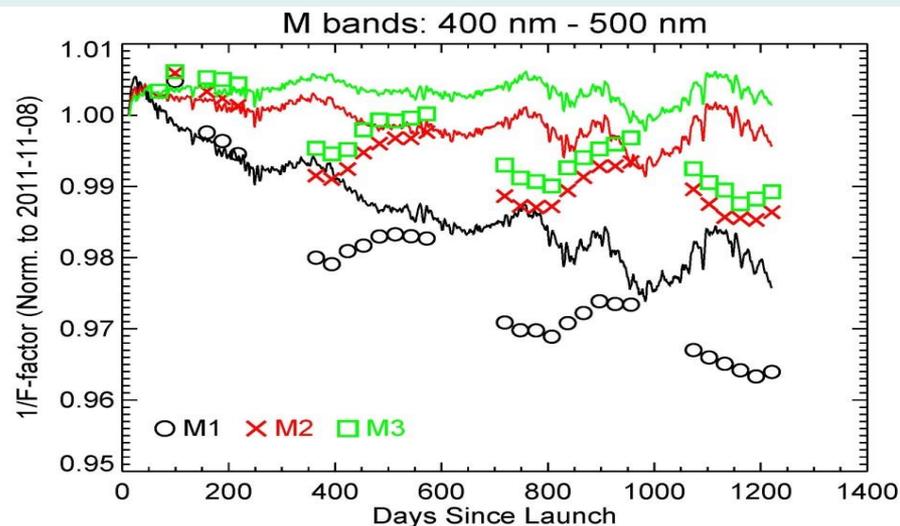
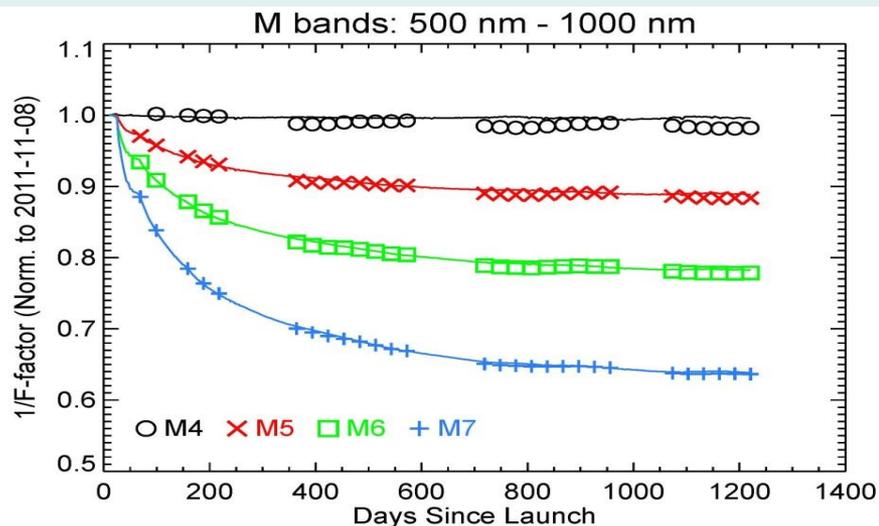
Aqua MODIS Radiometric Responses (VIS/NIR/SWIR)



Large changes in VIS and NIR responses

Wavelength, AOI, and Mirror-side dependence

S-NPP VIIRS Radiometric Responses (VIS/NIR/SWIR)



Large changes in NIR and SWIR responses

Small features observed in SD and lunar calibration trends

Importance of CLARREO and need for improved lunar models

Status of MODIS and VIIRS L1B Data Products

- **Status of MODIS Level 1B Collection 6 (C6)**
- **Status of VIIRS SDR Code/LUTs**
 - IDPS effort (operation)
 - NASA L1B effort (research)

Status of MODIS Level 1B Collection 6 (C6)

- **Planned as early as Jan, 2008**
 - ✓ *Development of improvements to algorithms and LUTs*
 - ✓ *Extensive interactions with science disciplines*
- **Proposed changes reviewed and approved by Feb, 2012**
 - ✓ *Implantation and data production*
- **Products (L1B) released to public July, 2012 for Aqua and Nov, 2012 for Terra**
- **C6 L1B data can be downloaded from:**
<http://ladsweb.nascom.nasa.gov/>
- **New improvements**
 - ✓ *Correction for Terra B5 long-term drift*
 - ✓ *RVS (more bands use earth view trending for RVS characterization)*

Status of VIIRS SDR Code/LUTs

- **IDPS VIIRS SDR Code/LUTs (radiometric)**
 - 23 major code versions post launch (current Mx8.5); numerous LUT updates.
 - Improved LUT update strategy (on demand -> weekly -> automated).
- **Support for NASA SIPS SDR Code/LUTs and data reprocess (C1.0 and C1.1)**
 - Independent validation and improvements for SDR code/LUTs.
 - 23 sets of LUTs for VISNIR/SWIR/DNB delivered to Land SIPS for data reprocess and SDR/EDR assessments.
 - Jan 31, 2013: LUTs from Jan 2012 to Jan 2013 generated using IDPS algorithm Mx6.3 with smoothed functions to remove outliers.
 - Nov 13, 2013: LUTs from Jan 2012 to Oct 2013 generated with calibration improvements based on Mx6.4, including SD/SDSM screen transmission, SD BRDF, RTA mirrors degradation model, modulated RSRs, and smoothed fitting functions.
 - Mar 12, 2014: LUTs from Jan 2012 to Nov 2013 generated with VCST “best” sensor characterization improvements based on Mx7.2 algorithm for Land PEATE reprocess Collection 1.1, including DNB Stray Light Correction algorithm and smoothed fitting functions.
 - Feb 19, 2015 – Latest LUTs update V7.2.0.13 for the month of Jan 2015.
 - Ready for Mx8 mission LUTs update and reprocess – including solar vector error correction, new SD/SDSM screen transmission and SD BRDF, and modulated RSR.

Challenging Issues and Future Efforts

- **MODIS:**
 - Large changes in VIS/NIR responses: mirror side, wavelength, and AOI dependent => RVS
 - On-orbit changes of Terra MODIS VIS/NIR polarization sensitivity
 - SD degradation correction for SWIR calibration
- **VIIRS:**
 - Large changes in NIR/SWIR responses: wavelength and time dependent => modulated RSR(t)
 - Large SD degradation (no SD door) and correction for SWIR calibration
- **Future efforts**
 - Improve MODIS RSB RVS characterization: using ground targets; exploring new methodologies, removing/reducing impact due to polarization
 - Improve SWIR calibration: developing alternative approach for SD degradation correction
 - Examine S-NPP VIIRS and Aqua MODIS calibration consistency via different approaches and methodologies

Landsat-8 OLI Calibration Status Update

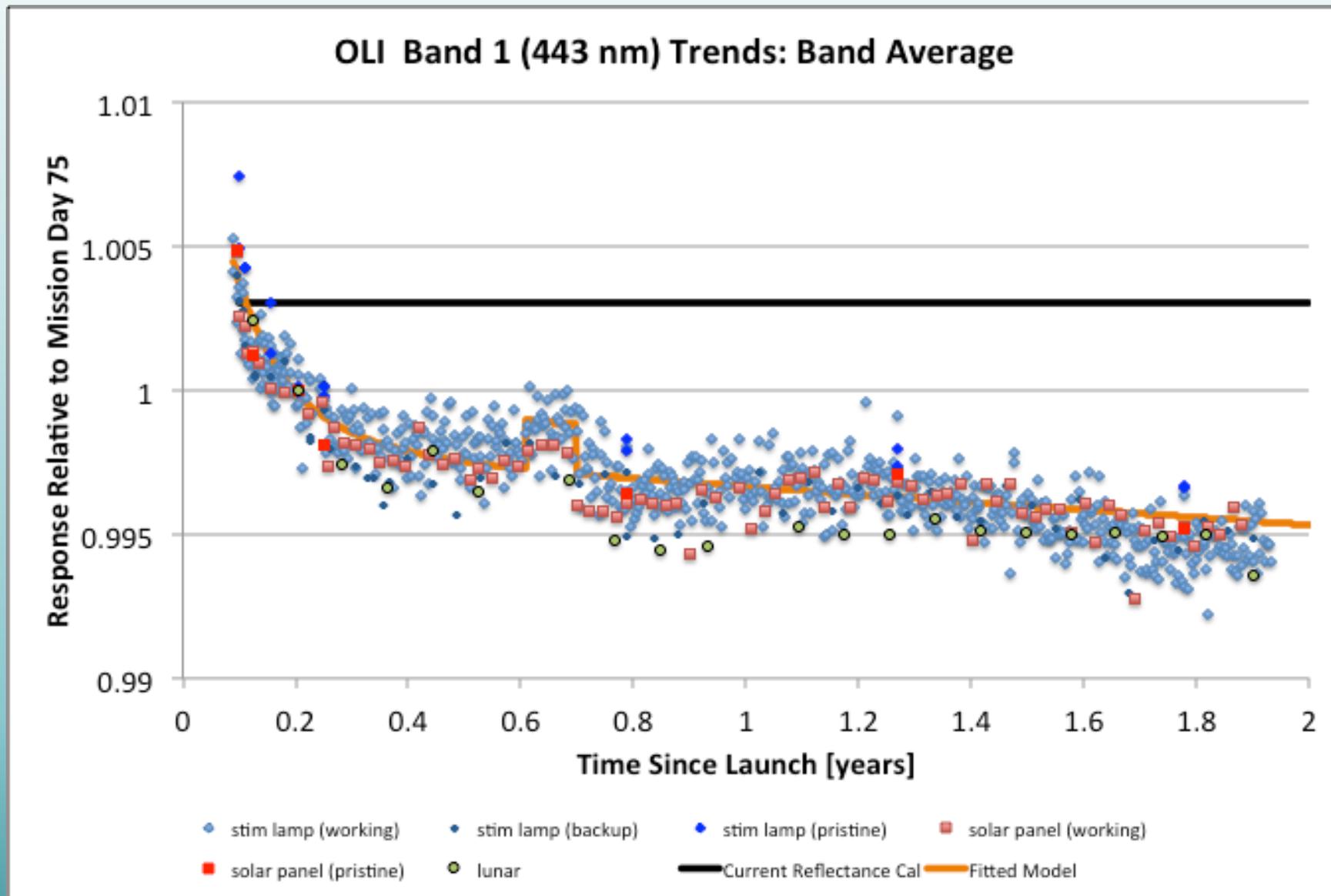
- **Stability**

- Only band with significant trend is 443 nm (Coastal Aerosol) ~1.0% degradation over 2 yrs
- Other bands stable to within ~0.3% or better
- All calibration techniques (diffusers (2), lamps (3), and lunar) consistent to within 0.3% or better
- Scatter in SWIR lunar data under study

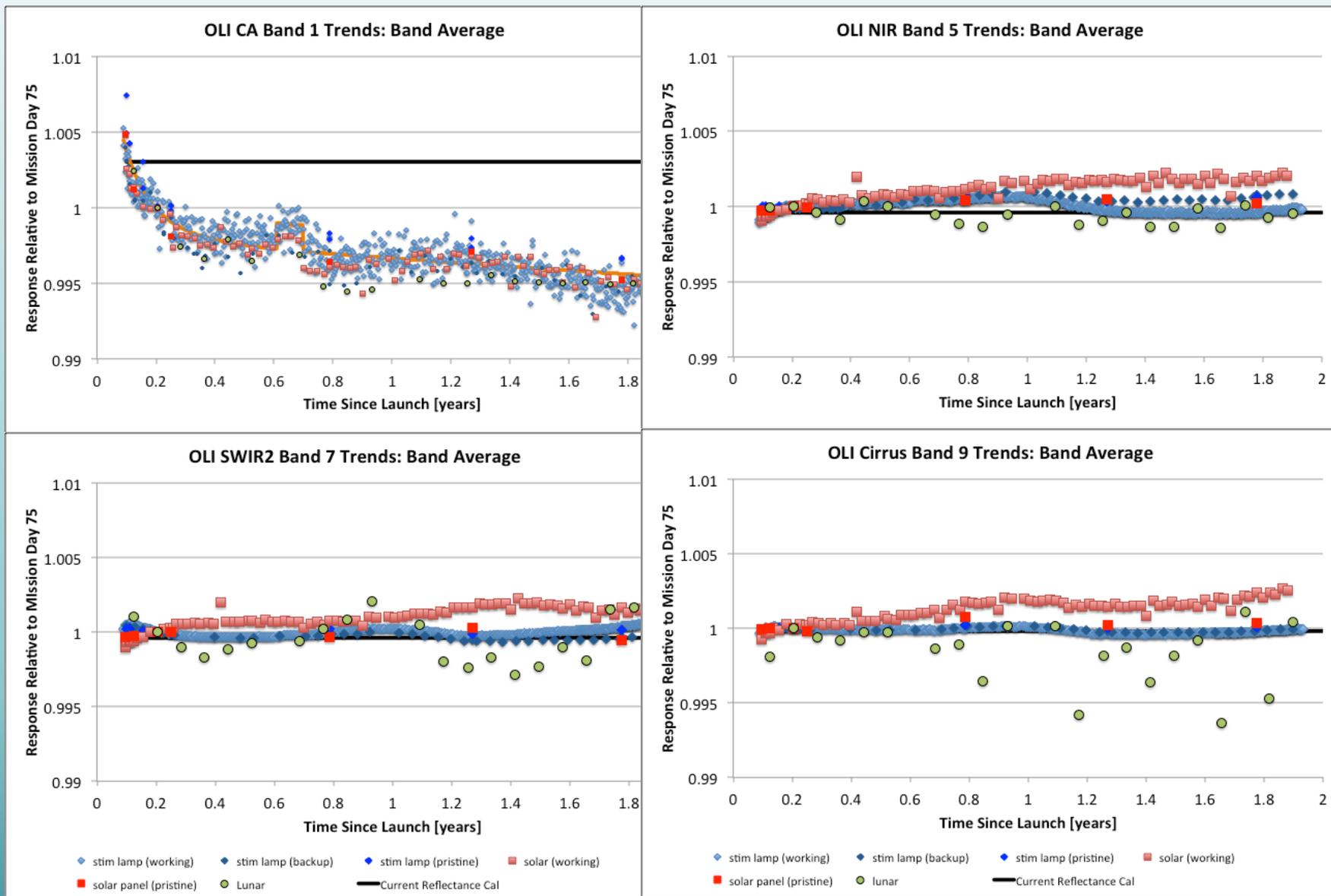
- **Absolute Calibration**

- Reflectance calibration consistent to within 5% with field (vicarious) measurements (better than 3% in most bands)

OLI Radiometric Calibration Stability (1 of 2)



OLI Radiometric Calibration Stability (2 of 2)



OLI Vicarious Calibration Results (Czapla-Myers et al, 2015)

